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Follicular Development and Gonoactivity in *Armigeres subalbatus* Females under Various Conditons

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ABSTRACT : With *Armigeres subalbatus*, follicular size and stage, the activity of blood feeding and incidence of gonotrophic dissociation were examined with females which had been reared as adults under the outdoor natural or indoor experimental conditions and with those which had been caught at cowsheds. Also, parous rate was investigated with unfed females caught by a dry ice trap. From the results obtained, it was found that the follicular development does not vary from spring to autumn, and is not influenced by short day-length and low temperature, however, feeding activty is inhibited by low temperature. The gonotrophic dissociation was seldom observed under those conditions. The parous rate increased in autumn. Therefore, it is assumed that most of the females which emerged under short day-length in autumn do not show the diapause state represented by the small sized follicles as seen in *Culex pipiens* and will die by next spring by repeating the feeding activity and egg-laying.

In *Culex pipiens* Complex and *Culex tritaeniorhynchus summorosus* it is reported that most of the females which emerge under short day-length of experimental and natural conditions generally have small sized follicles and do not feed on blood, that is, they are in the state of diapause (Kawai, 1969; Oda, 1968, 1971; Oda and Kuhlow, 1973; Sanburg and Larsen, 1973; Spielman and Wong, 1973). However, it is not apparent whether the diapause phenomenon of this type is shown only in those mosquitoes written above or it is also seen in mosquitoes belonging to other genera. To make sure of this point, we examined the size and stage of follicles, feeding activity and incidence of gonotrophic dissociation (In this phenomenon, female mosquitoes take blood meal but their ovaries do not develop) with *Armigeres subalbatus* females which emerged under various conditions. Those results are reported in the present paper.

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MATERIAL AND METHODS

The larvae from the laboratory colony were bred with an equally mixed powder of Ebios (brewer' yeast) and mouse pellets, and the resulting adults were kept in a cage with 2% sugar solution at an outdoor insectarium under natural conditions and at indoor insectaria with constant temperatures and alternate light and darkness. The follicular development was observed under a binocular stereoscope and a microscope. For the classification of the follicular stage in this species, the definition by Oda (1971) was applied. The females were exposed to a chicken for a night to observe the feeding activity, and the rate of gonotrophic dissociation was examined with the fed females 7−10 days after feeding. Besides the females of the laboratory colony mentioned above, the examination for parous rate and incidence of gonotrophic dissociation were made with the unfed females collected by a dry ice trap, and the fed females which had been caught at cowsheds and then kept under outdoor conditions for 7−10 days.

RESULTS

Results on the examinations of follicular size and stage in unfed females which had been reared from the lst instar larvae under outdoor conditions in the period from April to October are given in Table 1, which shows that the follicles were large in size and generally well-developed to the stage of IIa throughout the period.

The developmental states of follicles, feeding activity and gonotrophic dissociation rate were examined with the females which had een reared as adults under the experimental conditions with photoperiods ranging from 8 to 16 hours at temperatures of 15−30°C (Table 2). This table indicates that the follicles were usually large in size and well-developed in stage in any of the conditions, but the feeding rates had the tendency to become low with lowering temperature. The incidence rate of gonotrophic dissociation was, on the whole, low regardless of photoperiods and temperatures, though by unknown reason the rate was high in females under 8 hours day-length and 21°C temperature.

Table 1. Developmental states of the follicles in *Armigeres subalbatus* females reared from lst instar larvae under the outdoor conditions in spring to autumn

Time of emergence	No. ♀♀** dissected	No. ♀♀ with the 1st follicles of indicated sizes*									Developmental stages
		10−	11−	12−	13−	14−	15−	16−	17−	18−	
Early Apr.	10				3	4	3				IIa
Middle Jun.	5			1	3	1					IIa
Middle Aug.	10		1	4	2	3					IIa
Late Sep.	10	not maeasured									IIa
Early Oct.	13***						2	0	1		Ib-IIa

* 1 unit = 10μ

** They were dissected 7−10 days after emergence.

*** The follicular size was measured with 3 females.

The gonotrophic dissociation rate in nature was examined with the females which had been caught at cowsheds in the period from April to October and then were kept for 7−10 days under outdoor conditions. Those results are given in Table 3, which indicates that gonotrophic dissociation of those females was very low in rate throughout this season.

The parous rate was obseraed by examining tracheoles attached to the ovary and the dilatation of ovarioles in the females which had been attracted to a dry ice trap (Table 4). From this table, it is apparent that the parous rate was high in autnmn, but in the next spring nulliparous females only were collected, though the number of mosquitoes was very small. The high parous rate in autumn is considered to be due to the fact that a large proportion of diapausing larvae results in only a few emerging adults in

Table 2. Follicular development, feeding activity and gonotrophic dissociation in the females of *Armigeres subalbatus* reared from lst instar larvae under the combind conditions with various photoperiods and temperatures

Temp. (°C)	photo-period (hr:min)	Days after emergence to dissection or feeding	No. ♀♀ dissected	No. ♀♀ with the lst follicles of the indicated sizes								Develop-mental stages	Feeding rate			Gonotrophic dissociation		
				11–	12–	13–	14–	15–	16–	17–	18–		No. exposed	No. fed	%	No. fed	No.** showing	%
30	14:00	10	10	1	0	2	2	2	2	1		Ib–IIa	38	14	36.8	14	0	0.0
25	16:00	10	11			3	3	3	1	1		IIa	50	46	92.0	15	1	6.7
21	16:00	20	10	1	0	0	0	4	3	2		IIa	42	30	71.4	21	3	14.3
21	12:00	10	19	1	3	4	7	2	1	1		IIa	160	136	85.0	50	0	0.0
21	11:30	15	3			1	2					IIa	—	—	—	—	—	—
21	9:00*	15	11		1	1	5	3	1			IIa	28	16	57.1	16	0	0.0
21	8:00	10	8			3	1	2	2			Ib–IIa	57	15	26.3	7	4	57.1
15	16:00	20	10					1	2	3	4	IIa	45	13	28.9	12	1	8.3
15	12:00	10	9				2	5	1	0	1	Ib–IIa	29	5	17.2	5	0	0.0

* The larvae had been bred to third instar under the condition with temperature of 25°C and photoperiod of 16hr and then were transferred into the condition with temperature of 21°C and photoperiod of 9hr.

** They were dissected 7−10 days after taking blood meal.

Table 3. Seasonal change in the rate of gonotrophic dissociation in the fed females of *Armigeres subalbatus* which had been collected at cowsheds and pigsties and thereafter kept under outdoor conditions

Date of collection	No. ♀♀* dissected	Gonotrophic dissociation	
		No. ♀♀ showing	%
Apr. 17	2	0	0.0
May 2	41	0	0.0
Jun. 26	3	0	0.0
Jul. 27	30	2	6.7
Aug. 27	16	0	0.0
Sep. 16−27	81	0	0.0
Oct. 16	24	0	0.0

* They were dissected 7−10 days after collection.

this season.

In order to know whether the unfed females which emerged in late autumn are able to maintain gonoactivity till next spring, about 300 unfed females which had been reared as adults in early October were kept till early February. Most of the females died by early January and only five females survived till early February. Those five females were allowed to feed on the chicken under the outdoor conditions as well as at 25°C, but they did not feed on blood under both conditions. The morphology of the ovarioles in those females were examined. The results are shown in Table 5, which shows that many ovarioles in an ovary had many degenerate follicles as shown in Photo. B—D. Such females with many degenerate follicles were not found in unfed, nulliparous females which were caught by a dry ice trap in autumn and spring. Those facts may suggest that follicles degenerate commonly when unfed females are reared for a long time without being allowed to take the blood meal.

Table 4. Seasonal change in parous rate in *Armigeres subalbatus* females caught by a dry ice trap

Date of collection	No. dissected	No. nulliparous	No. parous	Parous rate (%)
Apr. 6	6	6	0	0.0
May 3	8	8	0	0.0
Jul. 7	9	7	2	22.2
Aug. 22	28	25	3	10.7
Sep. 27	6	5	1	16.7
Oct. 7	22	11	11	50.0
Oct. 23 —Nov. 12	34	13	21	61.8

Table 5. Number and percentage of the ovarioles with the degenerate follicles in an ovary in *Armigeres subalbatus* females which had been reared as adults in early October and thereafter kept till early February under outdoor conditions

Mosq. No.	No. of ovarioles	Ovarioles with degenerate follicles	
		No.	%
1	121	121	100.0
2	137	72	52.6
3	100	14	14.0
4	118	60	50.8
5	137	48	35.0

CONCLUSION

In the present experiment with *Armigeres subalbatus*, females which had emerged from spring to autumn under outdoor conditions, or under experimental conditions with various photoperiods and temperatures had well-developed follicles in size as well as in stage, but the feeding activity became low at low temperature. The incidence of gonotrophic dissociation was generally low in females under the experimental and natural conditions. The parous females increased in rate in autumn. Among ca. 300 females with well-developed follicles which had emerged in early October, only five survived till early February under natural conditions. From those findings, it can be said that the females of the present mosquito which emerged under short day-length in autumn do not show the diapause state represented by the follicles suspended in development, as seen in *Culex pipiens* Complex and *Culex tritaeniorhynchus summorosus*, and most of them will die by next spring by repeating the feeding activity and egg-laying in Nagasaki area.

REFERENCES

1) Kawai, S. (1969) : Studies on the follicular development and feeding activity of the females of *Culex tritaenirhynchus* with special reference to those in autumn. Trop. Med., 11 (3), 145−169.

2) Oda, T. (1968) : Studies on the follicular development and overwintering of the house mosquito, *Culex pipiens pallens* in Nagasaki area. Trop. Med., 10 (4), 195−216.

3) Oda, T. (1971) : On the effect of the photoperiod and temperature on the feeding activity and follicular development of *Culex pipiens pallens* females. Trop. Med., 13 (4), 200−204.

4) Oda, T. & Kuhlow, F. (1973) : Beobachtungen über Sterblichkeit und Follikelgrosse bei *Culex pipiens pipiens* L. im Verlauf der Überwinterung. Z. Tropenmed. Parasit., 24 (3), 373−378.

5) Sanburg, L. L. & Larsen, J. R. (1973) : Effect of photoperiod and temperature on ovarian development in *Culex pipiens pipiens*. J. Insect Physiol., 19 (6), 1173−1190.

6) Spielman, A. & Wong, J. (1973) : Environmental control of ovarian diapause in *Culex pipiens*. Ann. Ent. Soc. Amer., 66 (4), 905−907.

種々の条件下でのオオクロヤブカの濾胞の発育と生殖活性

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春から秋にかけての自然条件下で飼育羽化させたオオクロヤブカの雌及び種々の日長と温度とを組み合せた実験条件下で飼育羽化させた雌について濾胞の発育状態，吸血率及び栄養生殖分離率を調査し，さらに春から秋にかけて牛舎で採集した吸血雌についても栄養生殖分離率を調べた．またドライアイストラップで採集した未吸血雌の経産率の季節的変化を検討した．その結果次のことがわかった．本種の雌では濾胞の大きさと発育期は春から秋にかけて変化しないし，実験環境条件の低温短日下でも変らない．しかし吸血活動は低温下で抑えられる．栄養生殖分離はどの条件下でも一般に起らないようである．一方経産率は秋になると高くなった．以上の結果を総合して考えると，秋の短日条件下で羽化する本種の雌は，アカイエカやコガタアカイエカにみられるような休眠現象を示さず，吸血と産卵を繰り返して翌春までに死滅するものと思われる．

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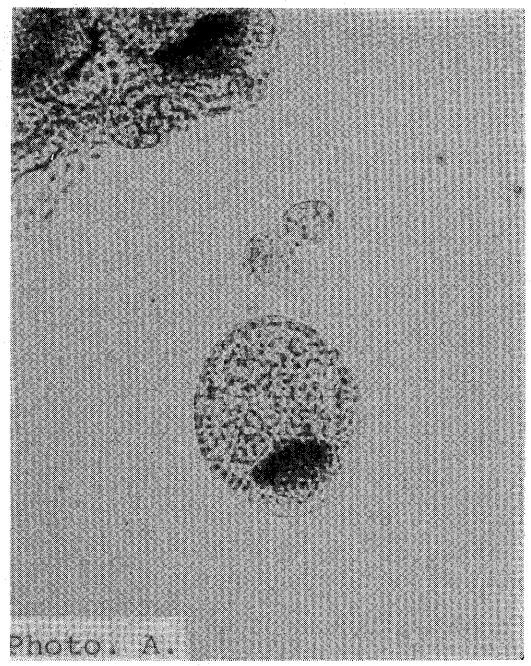

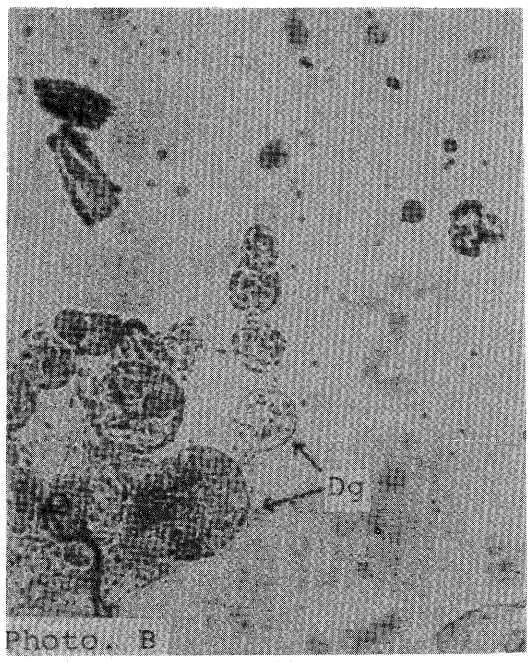

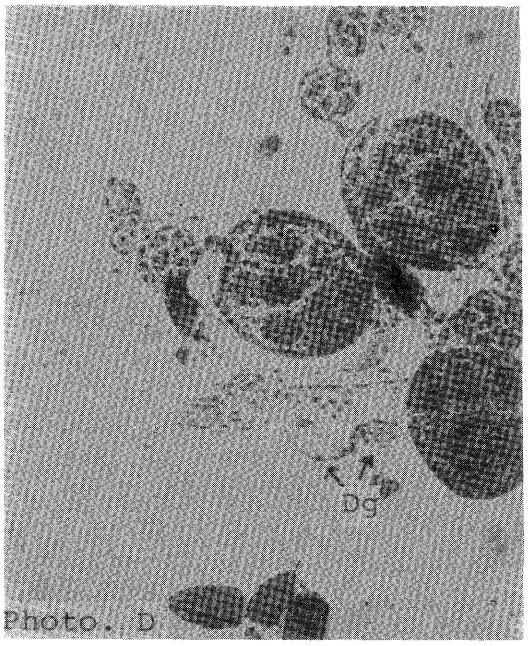

Photo. A. Ovariole with normal follicles.

Photo. B, C and D. Ovariole with degenerate follicles.

Dg. : Degenerate follicles